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(54) Projectile propulsive device

(57) A projectile propulsive device for propelling a projectile (53) under the action of fluid under pressure comprises a barrel (11,12,14,17) having an axial bore with a forward open end from which the projectile (53) is in use propelled by the fluid under pressure, a pressurised fluid supply chamber (23,25) and a valve (27) for controlling the supply of fluid under pressure from the supply chamber (23,25) to the bore of the barrel through one or more lateral apertures (26) in the barrel. To reduce the recoil of the device upon firing, the bore of the barrel is provided with a rearward open end (19), whereby at least part of the forward thrust of the fluid under pressure in the axial bore of the barrel is balanced by a rearward thrust of fluid under pressure discharged from the rearward open end (19) of the barrel.

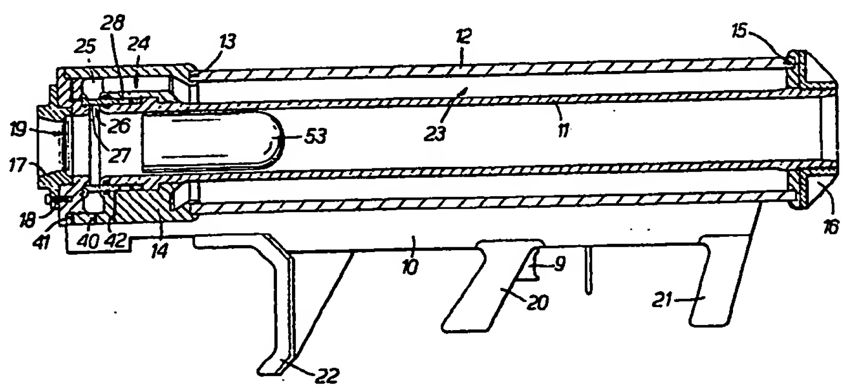

Fig. 1.

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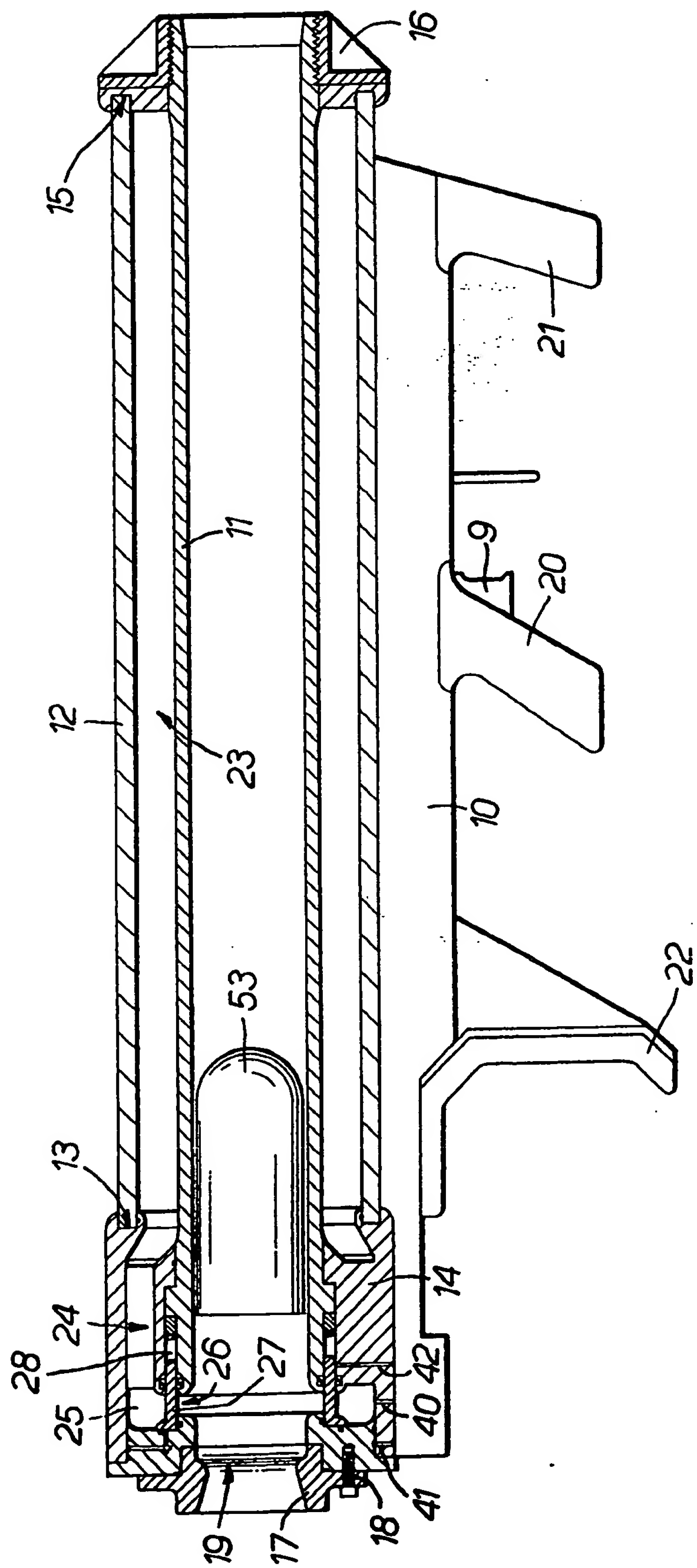

FIG. 1.

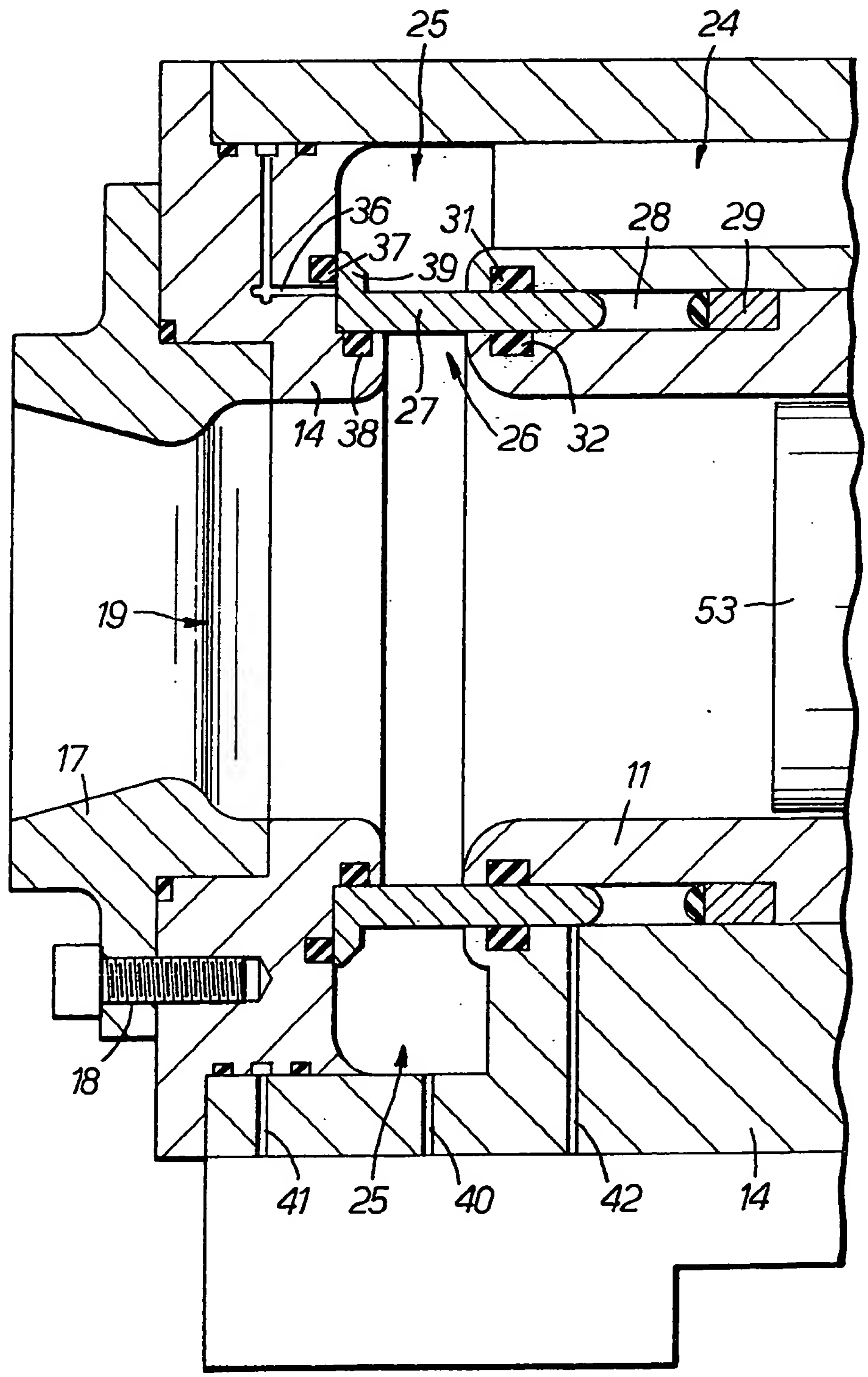

FIG. 2.

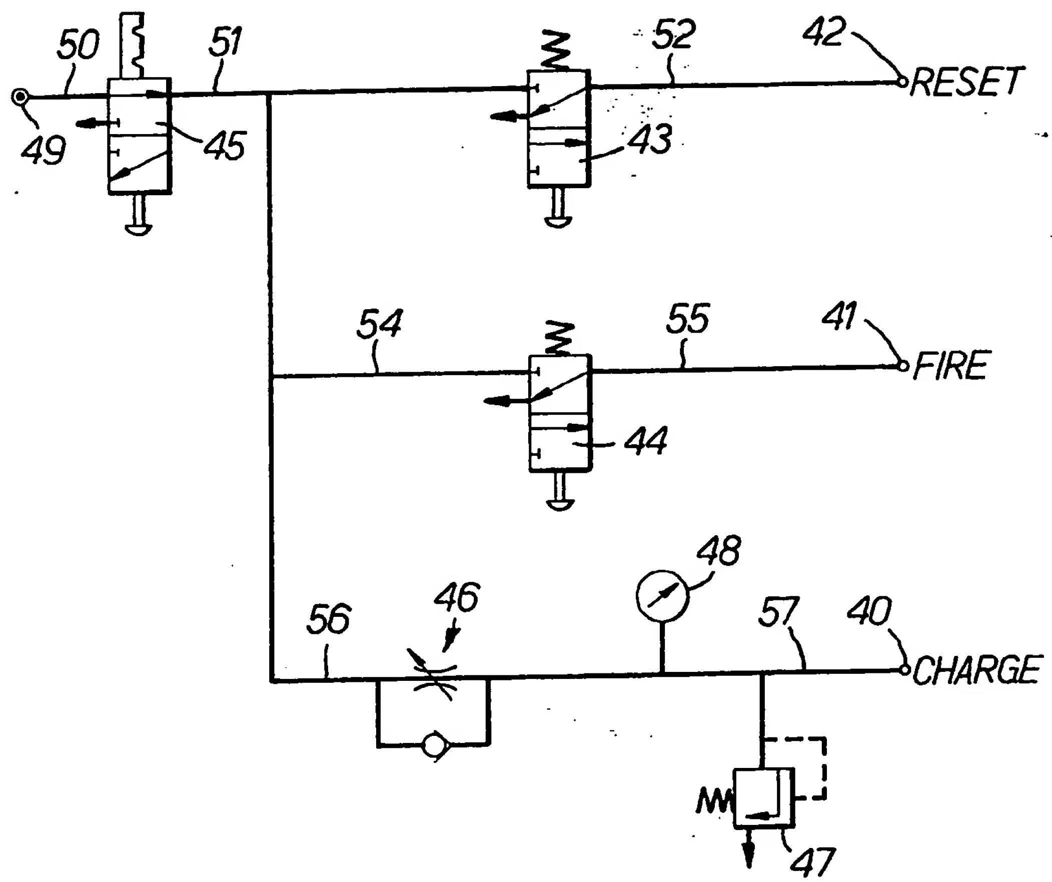

FIG. 3.

SPECIFICATION

Projectile propulsive device

The present invention relates to projectile propulsive devices and is particularly although not exclusively concerned with a projectile launching device for launching a projectile containing equipment which needs to be deployed at a location remote from the launching site.

Several types of projectile launching devices have been proposed which utilise air or gas under pressure for propulsion of the projectile from the launcher. The projectile is mounted in a launcher barrel having a forward open end and a rearward closed end and is launched by supplying air under pressure to the barrel at a position rearward of the projectile and allowing the pressurised air to act on the base of the projectile to propel the projectile along the barrel and discharge it from the forward open end. In all these launchers the forward thrust of the pressurised air on the base of the projectile is balanced by an equal and opposite force on the rearward closed end of the launcher tube with the result that a considerable recoil force is transmitted to the launcher. Where the launcher can be sited on hard ground or on a rigid structure the recoil forces are adequately absorbed and the accuracy of firing of the launcher not impaired. Where however the launcher is required to be fired for example from a soft ground surface such as a sandy beach the recoil forces are not adequately absorbed and give rise to a displacement of the launcher which adversely affects the firing accuracy and is a hazard to operating personnel. Additionally, where the launcher is mounted on say a light road vehicle or light marine craft the recoil forces are found to be absorbed by displacement of the vehicle or craft, which gives rise to inaccurate firing. On some occasions furthermore the launcher cannot be used if no stable position is available for mounting it.

It is an object of the present invention to provide a projectile launching device for launching a projectile under the action of air or gas under pressure which does not suffer from the above-mentioned disadvantages.

According to the present invention there is provided a projectile propulsive device for propelling a projectile under the action of fluid under pressure comprising a barrel having an axial bore with a forward open end from which the projectile is in use propelled by the fluid under pressure, pressurised fluid supply means, and valve means for controlling the supply of fluid under pressure from the supply means to the bore of the barrel through one or more supply apertures in the barrel, characterised by the fact that the bore of the barrel has a rearward open end, whereby at least part of the forward thrust of the fluid under pressure in the axial bore of the barrel is balanced by a rearward thrust of fluid under pressure discharged from the rearward open end of the barrel.

Preferably, the rearward open end of the axial bore of the barrel is formed with a throat end portion providing a constricted opening having a cross-sectional area smaller than that of the bore of the barrel and the throat end portion is removably mounted in the rearward open end of the axial bore of the barrel. Furthermore a closure end plate may be provided with the device which can be substituted for the throat end portion and which closes the rearward open end of the axial bore of the barrel so that the device can be operated by balancing the forward thrust of the fluid under pressure in the barrel by a rearward thrust on the closure end plate.

In a preferred embodiment of the invention, the throat end portion is formed with an axial bore and the constricted opening is formed therein by a gradual reduction in the cross sectional area of the bore in the direction of flow of fluid therein followed by a gradual increase in cross sectional area of the bore. The gradual reduction in cross sectional area of the bore of the throat end portion is preferably such as to form an annular shoulder within the bore and wherein the gradual increase in cross section is preferably such as to produce a conical enlargement of the bore.

Preferably, the pressurised fluid supply means comprises a chamber for containing fluid under pressure and communicating with the bore of the barrel through the one or more supply apertures and the valve means comprises a closure element movable between a closed position in which it closes the supply aperture or apertures and an open position in which it no longer closes the aperture or apertures. In a preferred embodiment of the invention the closure element comprises a sleeve coaxially mounted with respect to the bore of the barrel and axially displaceable along the barrel between the closed and open positions.

In an embodiment of the invention hereinafter to be described sleeve displacement means are provided for supplying to an end portion of the sleeve fluid under pressure to produce an axial displacement load on the sleeve to move it from the closed position in the direction of the open position. The sleeve is furthermore so constructed and arranged that when it is in the closed position it is subjected to an axial displacement load from the fluid under pressure in the chamber sufficient to hold it in the closed position in the absence of an application of fluid under pressure from the sleeve displacement means.

In the embodiment of the invention hereinafter to be described, the area of the end portion of the sleeve to which fluid under pressure is applied by the sleeve displacement means is such that the sleeve is moved from the closed position in the direction of the open position under a pressure no greater than that of the fluid in the chamber and the sleeve is held in the closed position solely by fluid under pressure in the chamber and is movable between the closed and open positions by external impressed forces produced solely by fluid under pressure.

In the embodiment of the invention hereinafter to be described, the end portion of the sleeve is arranged to engage an end portion of the barrel, the

end portion of the barrel is formed with two concentric resilient ring seals which engage the end portion of the sleeve and the sleeve displacement means is such as to discharge fluid under pressure from the end portion of the barrel in the area between the two seals. The chamber and the sleeve displacement means are arranged to be supplied with fluid under pressure from a single pressure fluid source. Further sleeve displacement means are also provided for supplying to an opposite end portion of the sleeve fluid under pressure to move the sleeve from the open position to the closed position and the further sleeve displacement means is arranged to be supplied with fluid under pressure from the single pressure fluid source.

The chamber for containing fluid under pressure and communicating with the bore of the barrel through the supply aperture or apertures needs to be of a robust construction which will support the high pressures to which it is subjected by the fluid in the chamber and in an embodiment of the invention hereinafter to be described the barrel is formed by an inner barrel tube having a rear end portion and a forward end portion, and an outer barrel tube which is coaxial with the inner barrel tube and which is held in compression between the rear and forward barrel end portions of the inner barrel tube by axial adjustment of one of the forward and rear end portions of the inner barrel tube, and the chamber comprises the annular space between the inner and outer barrel tubes. Preferably, the annular space between the inner and outer barrel tubes communicates with a further annular space, which is formed in the rear end portion of the inner barrel tube and communicates with the axial bore of the inner barrel tube through the supply aperture or apertures.

One embodiment of the invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a schematic sectional side elevation of a projectile launching device according to the invention,

Figure 2 is a cross sectional side elevation drawn to an enlarged scale of part of the launching device shown in Fig. 1.

Figure 3 is a schematic diagram of a pneumatic control circuit for controlling the operation of the device shown in Figures 1 and 2.

Referring first to Figures 1 and 2, the launcher shown comprises an inner barrel tube 11 of circular cross section, an outer barrel tube 12 also of circular cross section and supported in concentric relationship with the inner barrel tube 11 by engagement in a forwardly facing end groove 13 of a support block 14 mounted on the rear end of the inner barrel tube 11 and in an rearwardly facing end groove 15 formed in a clamping ring 16, which is screwed on to the forward end of the inner barrel tube 11 and tightened down to bring the outer barrel tube 12 under compression.

The support block 14 has a rear open end in which is mounted a throat end piece 17 held in place by clamping bolts one of which is shown in Fig. 1 and indicated by the reference numeral 18. The throat end piece 17 is formed with an axial bore which together with the axial bore of the rear end of the support block 14 and the axial bore of the inner barrel tube 11 form the axial bore of the launcher barrel. As will be seen, the axial bore of the throat end piece 17 is constricted at 19 by a gradual reduction in cross section followed by a gradual increase in cross section. The support block 14 is formed with a forwardly extending arm 10 fitted with hand grips 20 and 21 and a mounting support 22.

The annular space between the inner and outer barrel tubes 11 and 12 forms a chamber 23 which communicates through axial passageways 24 in the support block 14 with an annular space 25 formed in the rear of the support block 14 and opening into the axial bore of the launcher barrel through a fully circumferentially extending lateral aperture 26. A sleeve 27 is provided for closing off the annular space 25 from the lateral aperture 26 and is mounted coaxially with respect to the bore of the inner barrel tube 11 and is axially slidable in a guide slot 28 between a closed position as shown in Figs. 1 and 2 in which a rear end portion of the sleeve engages and abuts against an end portion of the support block 14 and an open position (not shown) in which it is retracted into the guide slot 28 and bears against a resilient buffer ring 29.

An inlet 42 in the support block 14 is provided for supplying pressurised air to the guide slot 28 which is sealed by ring seals 31 and 32 which engage with the sleeve 27. An inlet duct 40 is provided for supplying pressurised air to the annular space 25 and through the passages 24 to the chamber 23 and a further inlet 41 which communicates with a multiplicity of axially directed ducts 36 is provided for supplying air under pressure to the rear end portion of the sleeve 27.

The rear end portion of the sleeve 27 in the closed position of the sleeve firstly abuts against the forwardly facing end face of the support block 14, where it engages a concentric ring seal 37 mounted in the end face, and secondly engages over a forwardly projecting boss portion of the block 14, where it engages a ring seal 38 mounted in the boss portion. The air ducts 36 are positioned to direct air under pressure to the annular area between the seals 37 and 38 and the end of the sleeve 27 is radially extended by flange 39.

The construction of the rear end of the sleeve 27 and its manner of cooperation with the ring seals 37 and 38 are made such that when the sleeve 27 takes up the position shown in Figs. 1 and 2 it is held in that position by air under pressure in the annular space 25 acting on the flange 39 which is arranged to present an effective area to the pressurised air in the annular space 25 greater than that presented by the rear end face of the sleeve 27. The effective area of the rear end face of the sleeve 27 can be taken to extend to the inner periphery of the ring seal 37, the diameter of which is greater than the outer diameter of the main body portion of the sleeve. As a consequence of this, there is set up a net axial displacement load pro-

duced by pressurised air in the annular space 25 holding the sleeve 27 in the closed position shown in the drawings.

Furthermore, the construction of the rear end of the sleeve 27 and the disposition of the ring seal 37 is made such that the effective area of the rear end face of the sleeve 27 to which pressurised air from the ducts 36 is applied is greater than the net effective area presented by the sleeve to the pressurised air in the annular space 25. As a consequence of this, there is set up a net axial displacement load causing the sleeve 27 to move away from the forwardly facing end face of the support block 14 when pressurised air at a pressure equal to that in the annular space 25 is applied through inlet duct 41 and ducts 36 to the area of the support block 14 between the two ring seals 37 and 38.

A pneumatic control system for controlling the application of air under pressure to the inlets 40,41 and 42 is illustrated in Figure 3 and comprises two-position spring biased control valves 43 and 44 each provided with a relief port to atmosphere, a two-position on-off valve 45 provided with a relief port to atmosphere, a metering valve 46 with an associated non-return valve, a pressure regulator 47 with a relief port to atmosphere, and a pressure gauge 48.

Air under high pressure from a supply cylinder (not shown) is applied to an input 49 of the control system and fed through line 50 to the two-position valve 45 which in the position shown provides a communication between the line 50 and an output line 51. Air under pressure in line 51 is applied to the two-position valve 43 which is spring biased to the cut-off position shown in Fig. 3, preventing air under pressure from being supplied to output line 52. Similarly air under pressure is fed on line 54 to valve 44 likewise spring biased to its cut-off position as shown in Fig. 3 and preventing air under pressure from being supplied to output line 55. Finally air under pressure on the line 51 is applied through line 56 and the manually operable metering valve 46 to output line 57.

To facilitate the description of the operation of the launching device shown in Figs. 1 and 2, it will be assumed that the chamber 23 and annular space 25 have been charged by air under pressure supplied to the inlet 40 through the metering valve 46 and that the sleeve 27 is held in its closed position by the pressurised air in the annular space 25 with its rear end engaging the two ring seals 37 and 38 in the support block 14. The guide slot 28 is furthermore taken to be open to atmosphere through the valve 43 in Fig. 3.

To fire the launching device, the valve 44 is operated to move it from the position shown in Figure 3 to its other position in which pressurised air on line 54 is fed through it to inlet 41 and through ducts 36 to the forwardly facing end face of the support block 14 in the area between the two seals 37 and 38. As the inlet 42 is connected by the valve 43 to atmosphere in the position of the valve 43 shown in Fig. 3 and as the effective area of the end face of the sleeve 27 to which the pressurised air from ducts 36 is applied is arranged to be greater than that acted upon by the pressurised air in the annular space 25 the sleeve 27 moves forwardly in the guide slot 28. As soon as the sleeve 27 is clear of the seal 37 the high pressure air in the space 25 rapidly accelerates the sleeve 27 into the guide slot 28. With the rapid retraction of the sleeve 25 the base of the projectile 53 is acted upon over its full area by the pressurised air from the chamber 23 causing the projectile 53 to be propelled with high acceleration along the inner barrel tube 11 and to be launched from the end of the barrel tube. At the same time, part of the pressurised air from the chamber 23 passes rearwardly through the constricted opening 19 in the throat end portion 17 so that part of the forward thrust applied by the pressurised air to the projectile 53 is balanced by the rearward thrust of the pressurised air discharged rearwardly from the throat end portion 17. By forming the constricted opening 19 a smaller rearwardly moving mass of pressurised air at a higher velocity is used with advantage to balance a greater forwardly moving mass of air at a lower velocity. It will of course be appreciated that a small but insignificant recoil force is applied to the launching device by reason of the constricted opening. For most purposes this small recoil force can be ignored.

After firing of the projectile 53 the pressurised air charge in the chamber 23 and annular space 25 is expended and the device then needs to be re-set for the firing of a further projectile. Re-setting of the launching device shown in Figs. 1 and 2 is effected by first operating the control valve 43 so that it transmits air under pressure from the line 51 to the line 52 and inlet 42. Pressurised air at the inlet 42 is transmitted to the guide slot 28, causing the slide 27 to move back to the position shown in Fig. 1. With the valve 43 held operated, the metering valve 46 is then opened to supply pressurised air through line 57 to inlet 40 for re-charging the chamber 23 and the annular space 25. The valve 46 is then closed and the valve 43 released leaving the launching device ready for firing a further projectile front loaded into the inner barrel tube 11. The two-position on-off valve 45, which is normally in the position shown in Fig. 3, can be operated in an emergency to switch it into its other position in which it vents the line 51 to atmosphere and clears the launching device of pressurised air.

It will be seen that the projectile launching device illustrated in the drawings is of a very compact construction and is adapted to be fired by an operator from his shoulder. In use, he rests the device on his shoulder with the mounting 22 against it and supports the launcher by gripping the two hand grips 20 and 21. A trigger 9 is provided for firing the device and serves to operate the valve 44 of the pneumatic control system. The operator is subjected to little or no recoil from the device by virtue of the provision of the rearward open end formed by the throat end portion 17.

While the device described with reference to the drawings is suitable for shoulder firing, it will of course be appreciated that the support arm 10 can

readily be replaced by any other form of mounting to support the launcher for firing from a ground surface or from a motor vehicle or other craft, with the same advantage that only a relatively insignificant recoil force is developed when the device is fired.

It will furthermore be appreciated that the sleeve 27 functions solely under the application of pressurised air and for this reason is less likely to be subject to mechanical failure.

The compact construction of the launching device described with reference to the drawings has furthermore the added advantage that the inner and outer barrel tubes 11 and 12 are prestressed and better able to withstand the high pressures applied to them by the pressurised air fed to the chamber 23.

In the embodiment of the invention hereinbefore described with reference to the drawings, the closure element for closing off the lateral aperture 26 from the annular space 25 takes the form of the sleevé 27 which is movable between an open position in which it is retracted in its guide slot 28 and a closed position in which it engages an end portion of the support block 14. The flange 39 formed on the end of the sleeve 27 serves to ensure that the sleeve 27 is held in its closed position in abutment with the end face of the support block 14 by fluid under pressure in the annular space 25. It will however be appreciated that the feature of providing the barrel of the device with a rearward open end may be used with alternative means for closing off the aperture 26. For example, the sleeve 27 and the pneumatic control circuit which controls its displacement may, if desired, be replaced by the sleeve construction and pneumatic control circuit employed in the projectile propulsive device described in our copending British Patent Application No. 8314309, with appropriate changes being made to the support block 14 and the inner barrel tube 11 to provide for reception of the alternative sleeve and its movement between its open and closed positions.

CLAIMS

1. A projectile propulsive device for propelling a projectile under the action of fluid under pressure comprising a barrel having an axial bore with a forward open end from which the projectile is in use propelled by the fluid under pressure, pressurised fluid supply means, and valve means for controlling the supply of fluid under pressure from the supply means to the bore of the barrel through one or more supply apertures in the barrel, characterised by the fact that the bore of the barrel has a rearward open end, whereby at least part of the forward thrust of the fluid under pressure in the axial bore of the barrel is balanced by a rearward thrust of fluid under pressure discharged from the rearward open end of the barrel.

2. A device according to claim 1, wherein the rearward open end of the axial bore of the barrel is formed with a throat end portion providing a constricted opening having a cross-sectional area smaller than that of the bore of the barrel.

3. A device according to claim 2, wherein the throat end portion is removably mounted in the rearward open end of the axial bore of the barrel.

4. A device according to claim 3, comprising a closure end plate which can be substituted for the throat end portion and which closes the rearward open end of the axial bore of the barrel so that the device can be operated by balancing the forward thrust of the fluid under pressure in the barrel by a rearward thrust on the closure end plate.

5. A device according to claim 2, 3 or 4, wherein the throat end portion is formed with an axial bore and the constricted opening is formed therein by a gradual reduction in the cross sectional area of the bore in the direction of flow of fluid therein followed by a gradual increase in cross sectional area of the bore.

6. A device according to claim 5, wherein the gradual reduction in cross sectional area of the bore of the throat end portion is such as to form an annular shoulder within the bore and wherein the gradual increase in cross section is such as to produce a conical enlargement of the bore.

7. A device according to claim 6 wherein the throat end portion is substantially as hereinbefore described with reference to the drawings.

8. A device according to any of claims 1 to 7, wherein the pressurised fluid supply means comprises a chamber for containing fluid under pressure and communicating with the bore of the barrel through the one or more supply apertures and wherein the valve means comprises a closure element movable between a closed position in which it closes the supply aperture or apertures and an open position in which it no longer closes the aperture or apertures.

9. A device according to claim 8, wherein the closure element comprises a sleeve coaxially mounted with respect to the bore of the barrel and axially displaceable along the barrel between the closed and open positions.

10. A device according to claim 9, comprising sleeve displacement means for supplying to an end portion of the sleeve fluid under pressure to produce an axial displacement load on the sleeve to move it from the closed position in the direction of the open position.

11. A device according to claim 10, wherein the sleeve is so constructed and arranged that when it is in the closed position it is subjected to an axial displacement load from the fluid under pressure in the chamber sufficient to hold it in the closed position in the absence of an application of fluid under pressure from the sleeve displacement means.

12. A device according to claim 11, wherein the area of the end portion of the sleeve to which fluid under pressure is applied by the sleeve displacement means is such that the sleeve is moved from the closed position in the direction of the open position under a pressure no greater than that of the fluid in the chamber.

13. A device according to claim 12, wherein the sleeve is held in the closed position solely by fluid under pressure in the chamber and is movable be-

tween the closed and open positions by external impressed forces produced solely by fluid under pressure.

14. A device according to any of claims 10 to 13, wherein the end portion of the sleeve is arranged to engage an end portion of the barrel, wherein the end portion of the barrel is formed with two concentric resilient ring seals which engage the end portion of the sleeve and wherein the sleeve displacement means is such as to discharge fluid under pressure from the end portion of the barrel in the area between the two seals.

15. A device according to any of claims 10 to 14, wherein the chamber and the sleeve displacement means are arranged to be supplied with fluid under pressure from a single pressure fluid source.

16. A device according to claim 15 comprising further sleeve displacement means for supplying to an opposite end portion of the sleeve fluid under pressure to move the sleeve from the open position to the closed position.

17. A device according to claim 16, wherein the further sleeve displacement means is arranged to be supplied with fluid under pressure from the single pressure fluid source.

18. A device according to any of claims 9 to 17, wherein the barrel is formed by an inner barrel tube having a rear end portion and a forward end portion, and an outer barrel tube which is coaxial with the inner barrel tube and which is held in compression between the rear and forward barrel end portions of the inner barrel tube by axial adjustment of one of the forward and rear end portions of the inner barrel tube, and wherein the chamber comprises an annular space between the inner and outer barrel tubes.

19. A device according to claim 18, wherein the chamber comprises a further annular space which communicates with the first-mentioned annular space, is formed in the rear end portion of the inner barrel tube and communicates with the axial bore through the supply aperture or apertures.

20. A device according to claim 19, wherein a guide slot for the sleeve is formed in the rearward end portion of the inner barrel tube and wherein the sleeve is arranged in the closed position to close off the further annular space from the axial bore of the inner barrel tube.

21. A projectile propulsive device substantially as hereinbefore described with reference to the accompanying drawings.

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